CY2050 Single Family Homes Methods and Materials

(A Jan. 2024 Update as version 1.2 of an earlier version published in late 2021)

INTRODUCTION

This summary topic report update (version 1.2) concerns the need for supply of single-family homes in an increasingly resource challenged world such as will be the case in calendar year (CY) CY2050 and beyond.

Why single family homes and not apartments? This author believes that learning to live with climate change and its various effect need not impact our global society's standard of living appreciably. If ignored it will be disastrous. It can, though, in fact, enhance and improve our standard of living rather substantially. This short paper is one example of that simple but well researched perspective.

Interestingly, bits, pieces, and parts of that new home materials and supply exist now or will in the near future.

Some examples of these bits, pieces and parts would be using supercapacitors for off peak energy supply in a variety of existing application and the increasing use of ground or geothermal heating and cooling systems. Both examples are benefiting from increased use making them more robust and safer and much less costly. Some parts are becoming available now and in the near term such as transparent wood for windows, doors and monitors / televisions.

The missing ingredient to pull the product together that must be defined and proven is how to efficiently integrate those bits, pieces, and parts into a functional and appealing whole product. That product will need to be visually appealing, much more durable, simpler to assemble and far less costly than current stick-built homes. Further, this author advocates that this product can be used as a "package" globally without negative effect for anyone anywhere.

This author believes this product will be especially appealing by the CY2050 timeframe and beyond because global and national supply chains will be largely disrupted by climate change and its various effects. This will leave regional and local component supply and assembly the only reliable sourcing for the needed bits, pieces, and parts.

Currently, builders always have several "pairs of hands" touching the bits, pieces, and parts with their attendant stacked margins. Those hands inevitably delay

delivery and add cost and use of resources that needn't be spent. By CY2050 those delays and their need for additional specialized resources will be both cost and time prohibitive and may also cause real societal harm by attempting to use resources that can't be readily replaced or reused. Not least, the finished supply of aluminum and copper by CY2050 will be problematic. Urban mining and recovery of those metals will still be in its infancy. Therefore, effective work arounds need to be found and proven asap. Thankfully solutions do exist.

This author wants to provide a simple descriptive framework for methods and materials that will be available locally and at worst regionally. Ease of construction for least cost with extreme durability and with no associated loss in standard of living is my goal. I think my notes will outline this framework far better than a lengthy written description ever could.

First, an introduction of infrastructure as a topic and what it does and why housing is a key component within it seems useful. Infrastructure such as roads, bridges, power grids, housing and internet access is now required for any society to be successful.

Further, we are citizens of the most globally advanced society with no qualification. Maintaining that superiority requires that we find new ways to fund and force infrastructure development through time with both little input and monies from government. The need for infrastructure does not change but its needs do change. How to keep infrastructure both functional and relevant through time offers some real challenges that must be addressed, or societal failure will result. Oddly, single family housing as an integral part of infrastructure is often overlooked or simply forgotten. Why its forgotten could easily be its own paper.

A pertinent quote worth mentioning:

"Strength lies not in defense but in attack. Attack the problem"

Infrastructure can also be described as the backbone of society. Without continuous infrastructure development and support society either cannot exist, or it begins to fail if it had it and it fails without repair sufficient to keep it working. Societal failure can be difficult to recover from, if that is even possible, if history

teaches us anything. Infrastructure therefore requires funding and ongoing support that cannot be stopped. How we can do that as it pertains to single family housing is the subject of this simple and short paper.

Concept

Single family housing is ubiquitous throughout human society. It takes many forms depending on locale, cultural norms, climate demands and available materials. Commonalities do exist. They have walls, roofs, doors, windows and usually some method to heat them. In some locales cooling them is wanted and needed.

Increasingly in-home power distribution is becoming a requirement. Internet access may also be wanted or needed.

Answering all these requirements, wants and needs will, by CY2050, become a universal demand as our global society matures and broad existing inequalities largely disappear. Materials and methods to use them will be available by CY2050 to answer them all. No one design will exist, but a plethora of designs will be available or developed locally on an ad hoc basis. None will be too boring or too drab. Pride of place is a thing I believe. They will be energy efficient, durable, adaptable, and safe.

This author knows that his modest attempt at a look forward will change based on discovery and development through time. That is as it should be. His following notes section should answer most of the questions people will have and will pose many more.

Homes in CY2050 and beyond will need materials that can be sourced regionally. National and global supply of commodities will be difficult at best. Specialty supply of luxury components may be nearly impossible globally due to resource and energy constraints. That situation is not a bad thing, it will force innovation and creativity to answer that want.

Various forms of specialized cellulosic foams and materials will likely comprise the walls, roof, and flooring of homes. Cellulose can be sourced from many types of

vegetation including trees and waste packaging. Foaming materials are normally organic and can be sourced at worst regionally.

No use of mined hydrocarbons would be needed for housing any longer.

Said foams would be supported within a framework of roll formed steel struts to create stable and durable walls and roof. It would be pest proof with no following hazards. Exterior wall coatings would be largely spray applied carbon captured and colored concrete. Most houses would rest on a poured carbon captured concrete foundation with carbon fiber or compressed cellulosic “FRP” rebar. Wiring would be a copper / graphene alloy with very high conductivity and low resistivity. Wall imbedded graphene supercapacitors supplied with power from the local micro or smart grid would directly supply house power demands. All housing devices and appliances would use DC power for efficiency that eliminate inverter losses.

Summary Notes

General Notes and Observations:

- Housing by CY2050 will have a net zero-carbon lifecycle targeted for their manufacture and operation.
- Sustainability will be the watch word.
- Ground source heating and cooling will be ubiquitous.
- Utilities will be supplied by Smart Grid type sizing with DC throughout the home and possibly output from the local Smart Grid.
- In-situ energy storage will be commonplace.
- Renewable energy power sources will be both local and in-situ.
- Given the Smart Grid concept then expect that common district heating and cooling (DHC) will be commonplace.
- Germany's PassivHaus goal of 15 kwh/m2/y will be exceeded by at least 75%.
- UK's Code for Sustainable homes will be similarly exceeded.
- Global codes will be applied to all by that time.
- USA will largely be supplied by both regional and micro grid sources such as renewable energy.
- USA will likely adopt similar goals as the EU and other allies.

- Massless energy storage will be commonplace with structural batteries becoming common.
- Single family homes will be commonplace and in increasing demand.
- Custom designed family homes will still be commonplace.
- Most homes will target zero carbon balance for both construction materials and during use.
- Durability of homes will be on the order of 50+ years with 100+ years becoming the norm.
- Ground coupled water to water heat pumps and air to water heat pumps will be ubiquitous.
- Urban and suburban recovery of copper will be common to cover the expected shortfall of copper by that time.

Specific Notes:

- Sustainable construction methods and codes will be commonplace by CY2050.
- New construction single family homes will be compliant with those methods and codes.
- Construction materials and methods will be confined to local or at most regional supply.
- Copper (or aluminum) wiring will be difficult to reliably source by CY2050.
- Graphene alloyed copper wiring will be capable of regional manufacture and supply by CY2050.
- Graphene alloyed copper wiring will be at least 20% more conductive than conventional over gauge copper wiring.
- Graphene based supercapacitor energy storage devices will be common and sourced regionally by that time.
- Graphene supercapacitors will not require heat management.
- Graphene supercapacitors can be imbedded in the housing structure itself.
- Said supercapacitors will be the main source of power for the structure.
- Organic coating cladding of all wire should be self-healing.
- Said structure and all devices within it shall be DC powered.
- Distributed heat and cooling (DHC) sources shall be ground or geothermally sourced locally.
- DHC sources will be capable of supplying subdivision scale housing using below grade ducting to prevent pest, water, or tree intrusion.
- Local or residential temperature control will remain within limits or ranges.
- Supplemental heating or cooling devices may be used by permit.

- There will be no national electricity grid for security purposes.
- Housing will not use wooden board frame construction for any purposes.
- Housing will use regionally sourced roll formed steel framing of slip fit, bolted, or welded construction as may be required for seismic code compliance.
- Housing will use block formed wall with compressed cellulosic insulation providing at minimum R50 insulation from heat/cold and noise.
- Exterior coating will be spray applied CO2 reacted concrete coating with permanent coloring in a spectrum of choices suitable for the locale and climate.
- Interior walls shall have either sheet or spray applied cellulosic coating suitable for the application.
- Flooring whether planked or laid sheeting shall be highly compressed cellulosic material suitable for the application with an at minimum R30 rating.
- There will be no carpeting of any sort.
- A carbon captured cast in place foundation of concrete construction with support piers as needed will be used in all locales and will have an R60 rating.
- An alternative foundation and wall coating could be a color blended and compressed cellulose stabilized and cast with an ambient temperature cure epoxy resin matrix to replace concrete completely.
- Roofing shall be spray applied or sheet compressed cellulosic foam impregnated with PVA with and underlying cellulosic foam insulation capable of weight supporting roof mounted RE sources if considered desirable.
- Roofing shall also be compliant with snow and wind loads and stresses dependent on the locale with a minimum of R50 insulation value and preferably R90.
- RE sources to be solar passive / photovoltaic thin film or VAWT wind turbines or both preferable ground mounted for ease of installation and maintenance access.
- Trusses shall be roll formed steel of appropriate shape to handle any anticipated static and dynamic (wind) loads.
- Windows shall be triple pane transparent wood impregnated with PVA but capable of photoreactive shading and will provide a minimum of R30 insulation value.
- Doors shall be PVA or similar impregnated wood or transparent wood and shall be "sliding" in all instances and must provide an R50 insulation value or better when closed.
- Code compliance will be required in all instances.

- No national or internationally supplied materials should be used in construction, nor should it be necessary.

Conclusion

This report attempts to simply and briefly outline what single family housing materials and construction methods will look like in CY2050 and beyond. It further attempts to outline why this look forward might be useful and desirable.

This author believes that most people including government do not understand what the impacts of global climate change will be and how catastrophic its' societal impacts could be if ignored or approached improperly. If approached properly it needn't impact our global society negatively. A hopeful statement to be sure given this author's jaded worldview.

Simple changes in housing materials and methods of construction would go a long way toward mitigating those effects in any event.